# Short review on Power Couplers

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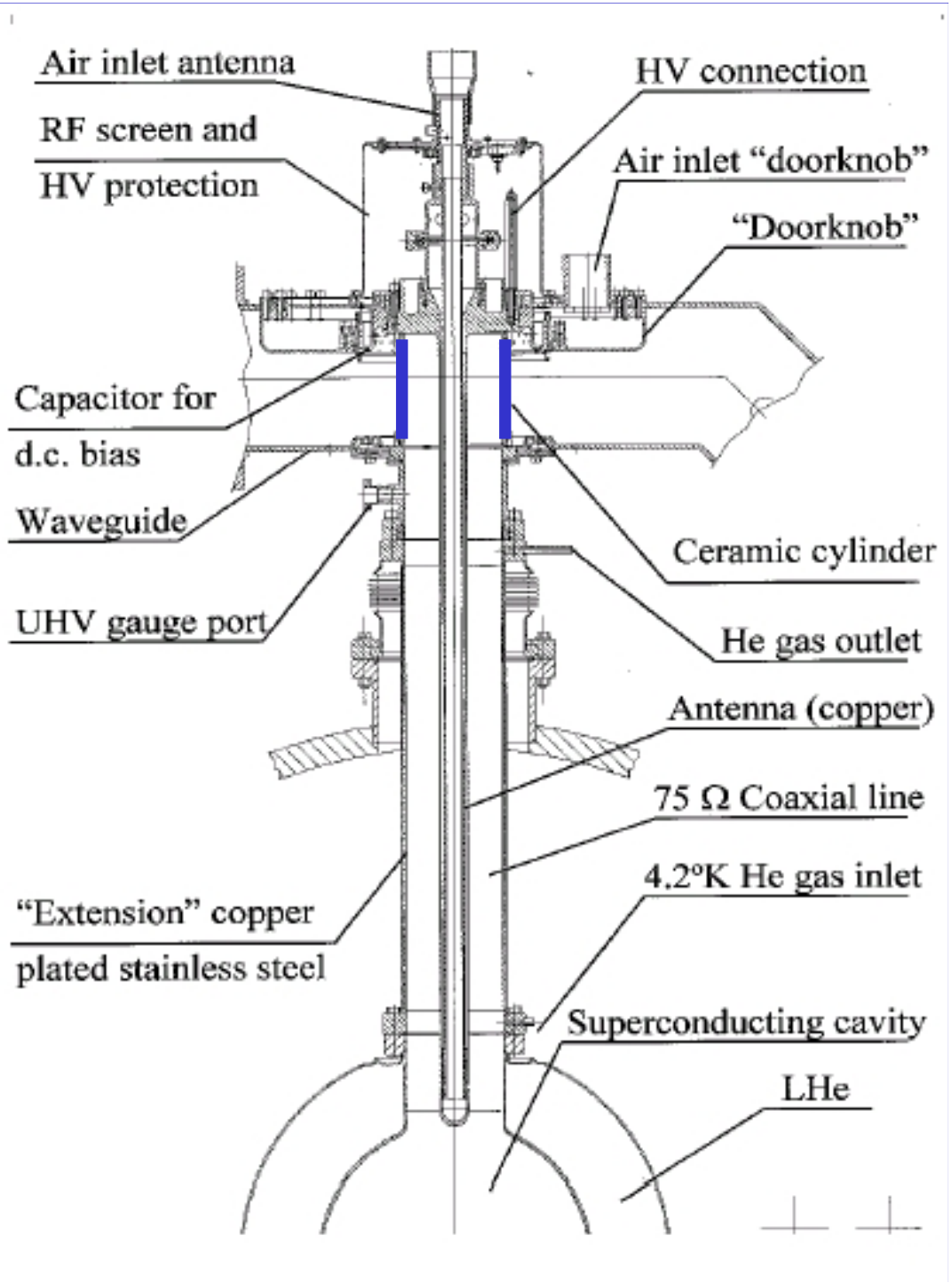
# Couplers under considerations

| | LEP | LHC | Cornell | KEKB | APT |
|---|---|---|---|---|---|
| | | | | | |
| **Frequency (MHz)** | 352 | 400 | 500 | 508 | 700 |
| **Status** | Operating on accelerator | Test stand | Operating on accelerator | Operating on accelerator | Test stand |
| **Number** | 288 | 2 | 4 | 4 + 4 | 8 |
| **Accelerator type** | e-synchrotron | p-synchrotron | e-synchrotron | e-synchrotron | p-linac |
| **Coupler type** | coax | coax | WG | coax | coax |
| **Mounting on cryostat** | from top | from top | from bottom | from top | from side |
| **Window type** | cylindrical | cylindrical | WG | disk | 2 disks |
| **Biasing** | yes | yes | no | yes | no |
| **Tunability range (mm)** | 0 | 60 | 0 | 0 | 10 |
| **Cooling type** | outer: cold He inner: air window: air | outer: 4,5 K He inner: forced air window: air | E-bend: LN2 WG transition: 4.5 K He Nb WG | outer: 4K He inner : water window: air | outer: 4,6 K He inner: 300 K He window: air |
| **Design power (kW) CW mode (TW)** | 140 | 120 | 325 | 270 | 210 |
| **Max. achieved power (kW) CW mode (TW)** | 565 on cavity | 500 room temperature 300 kW on cavity | 261 to beam | 380 to beam 800 on stand not biased 450 on stand with bias | 1011 room temperature 950 @ 70 K 950 with tunable |

**Note:** Numerous CW RF windows for room temperature RF systems are under operation and provide relevant experience for high power couplers for SRF linacs

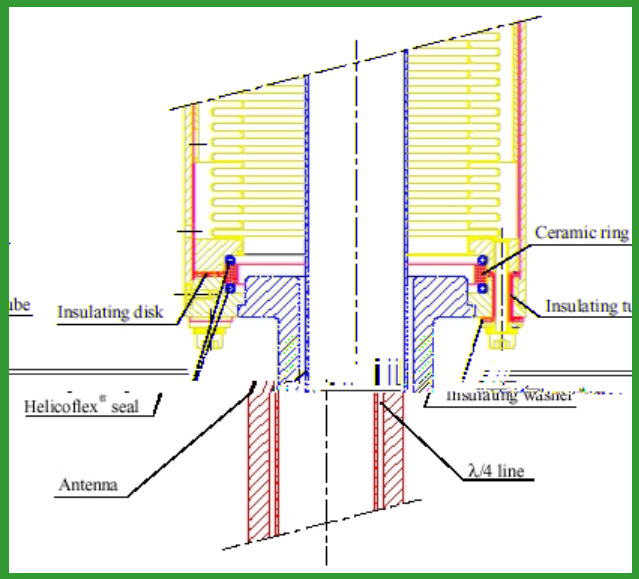
# LEPII coupler

**Main difficulties:**
**multipactor --> biasing**



# LHC coupler

**Main difficulties:**
**multipactor at 15 kW in 7Ω coax line --> additional biasing**



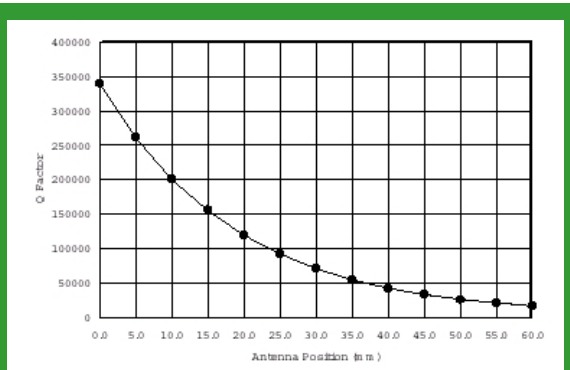
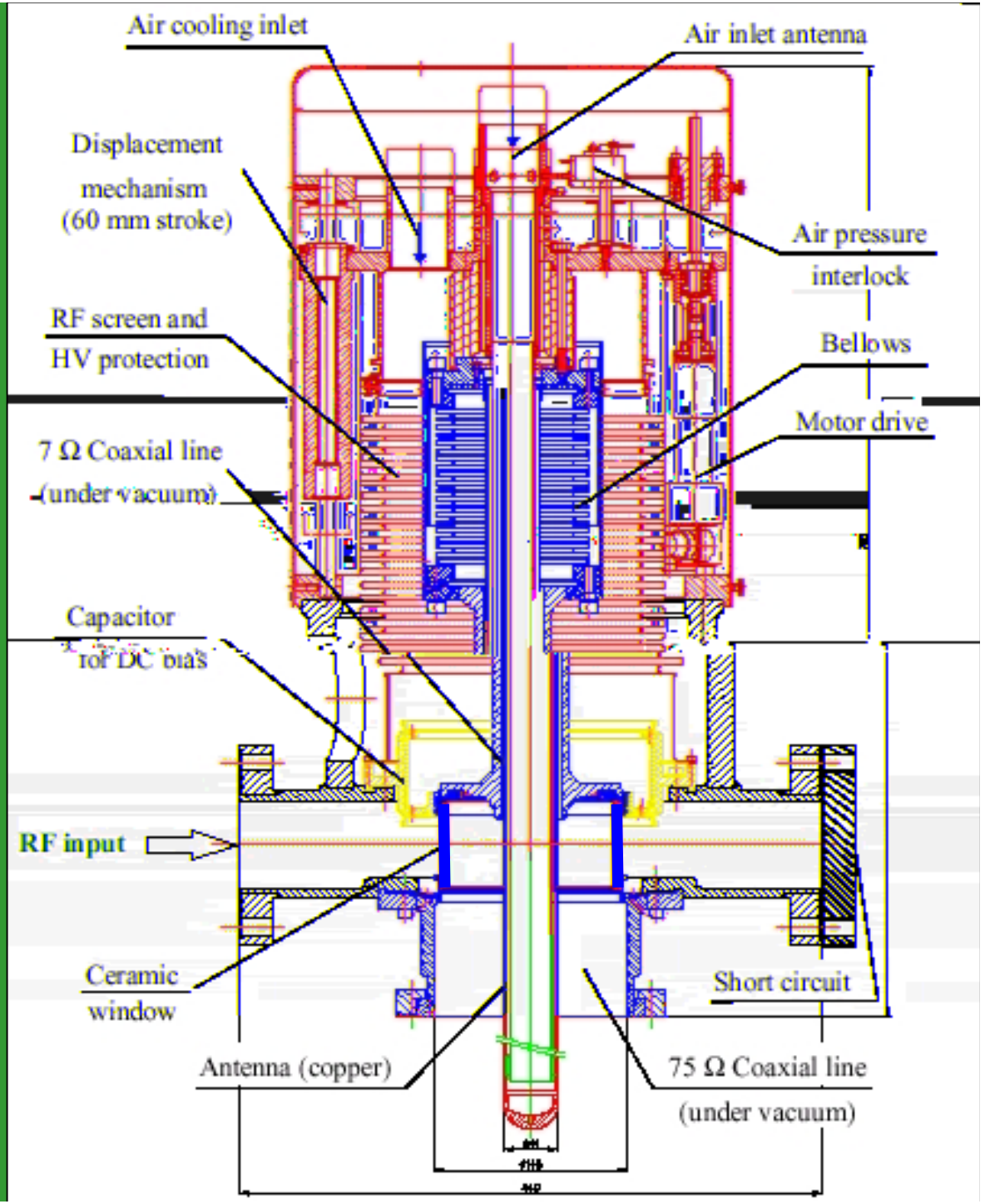
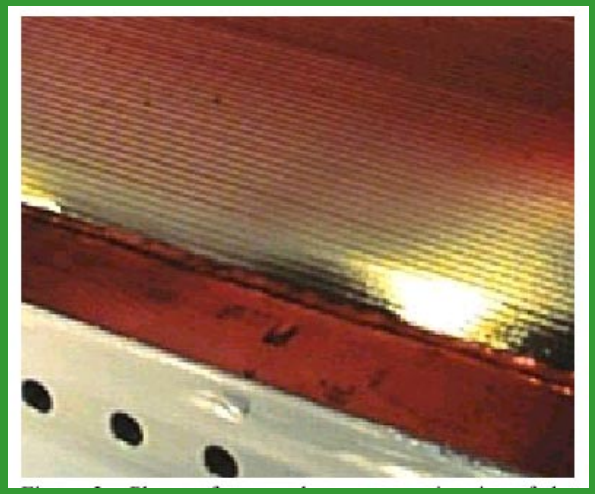



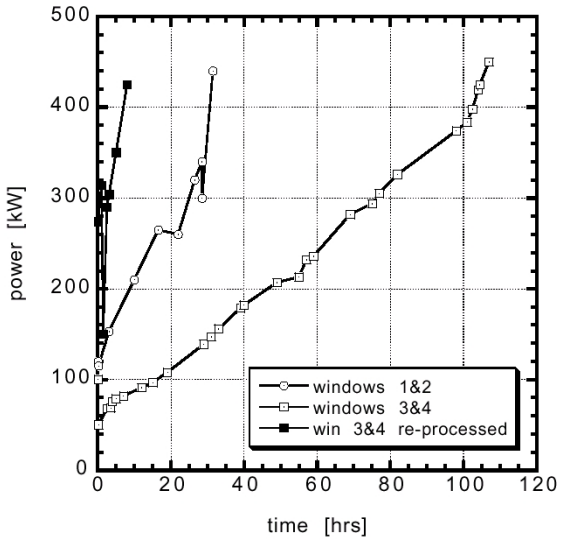

Figure 3: External Q as function of the antenna position.

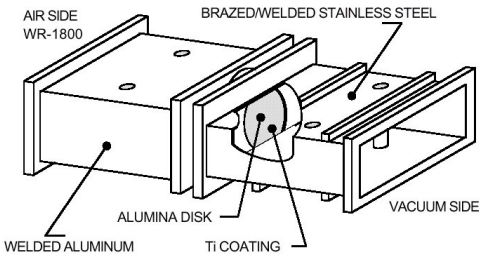


# Cornell coupler

**Main difficulties:**
**vacuum trips in double E-bend and/or Nb WG: multipactor on condensed-gas surfaces enhanced by corrugations --> baking, improved pumping, new tapered waveguide geometry, no corrugation,...**



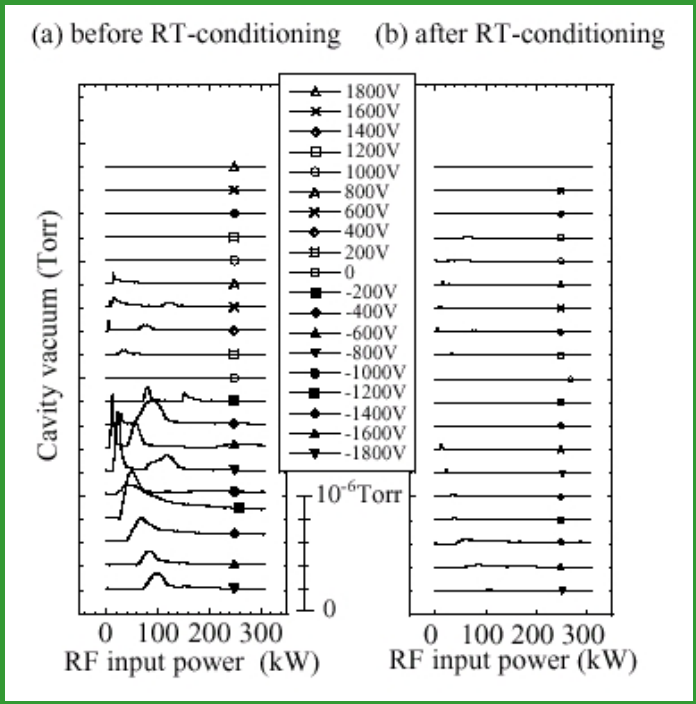


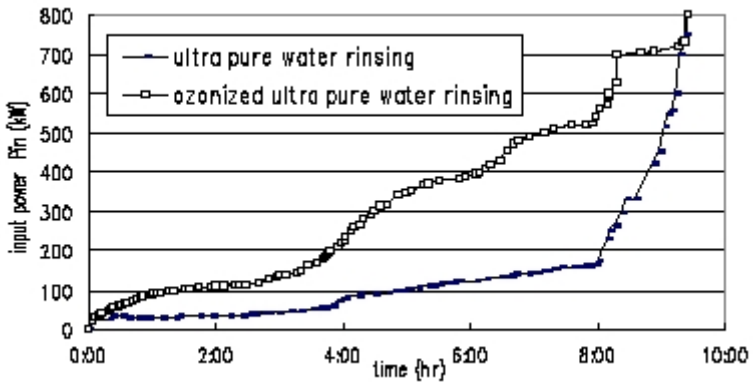




Off-line processing of windows

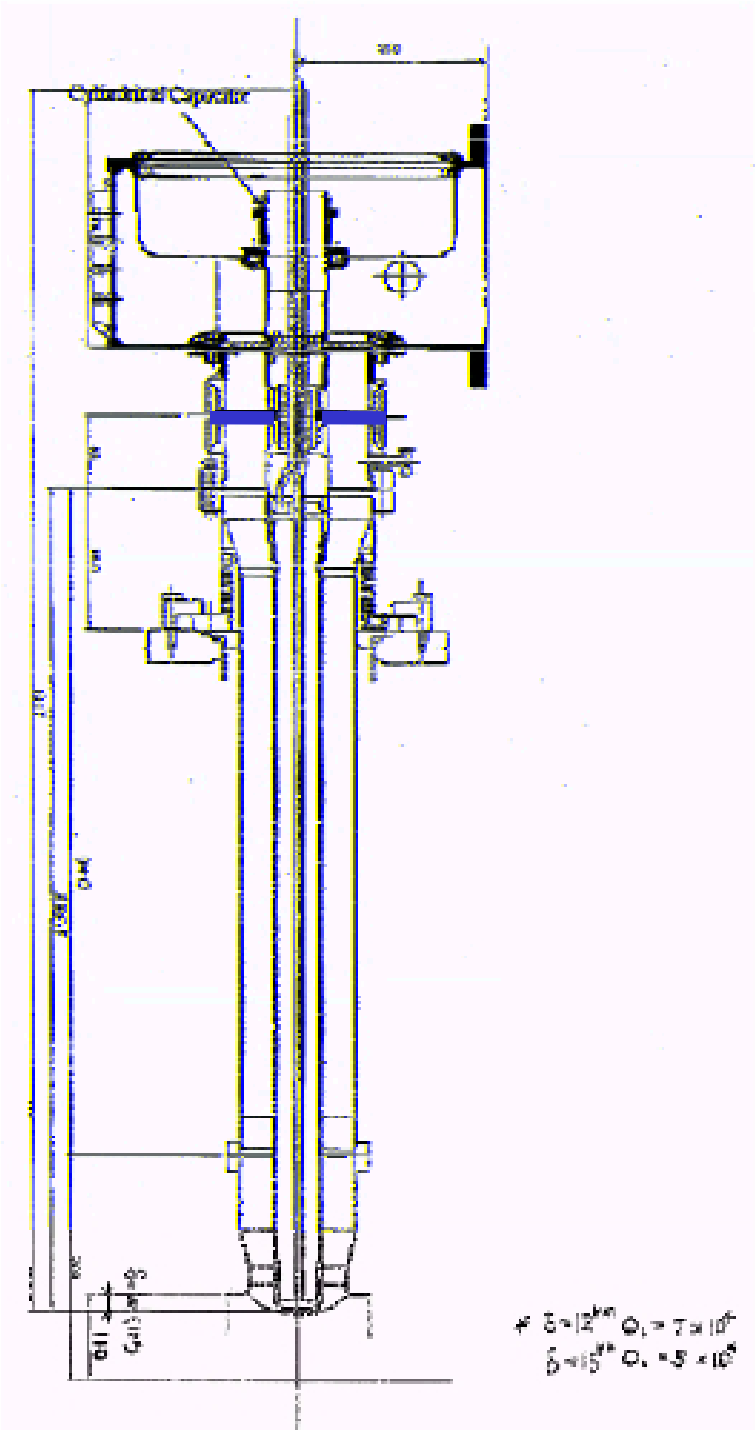
# KEKB coupler

**Main difficulties:**
**multipactor --> baking, conditioning with bias**



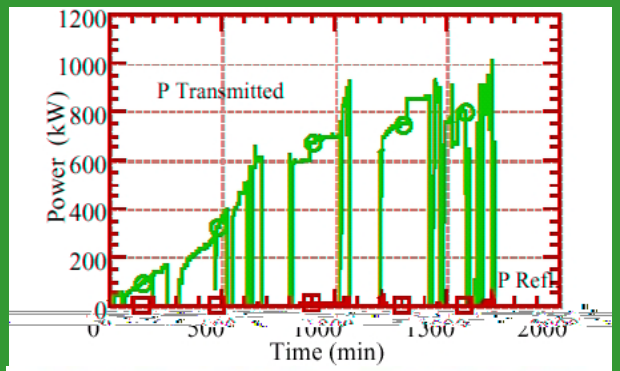

Off-line processing without bias

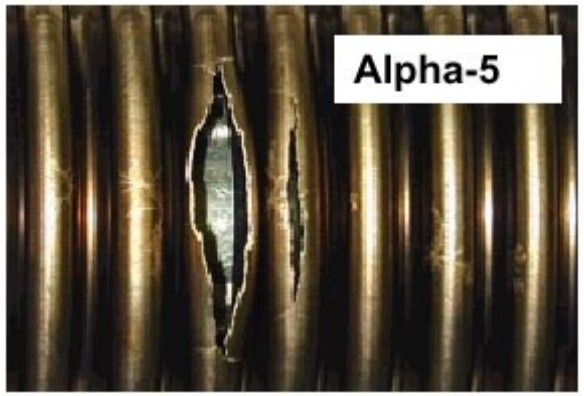


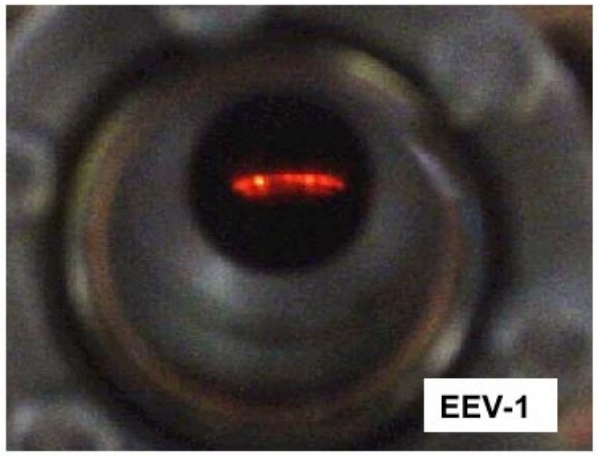
# APT coupler

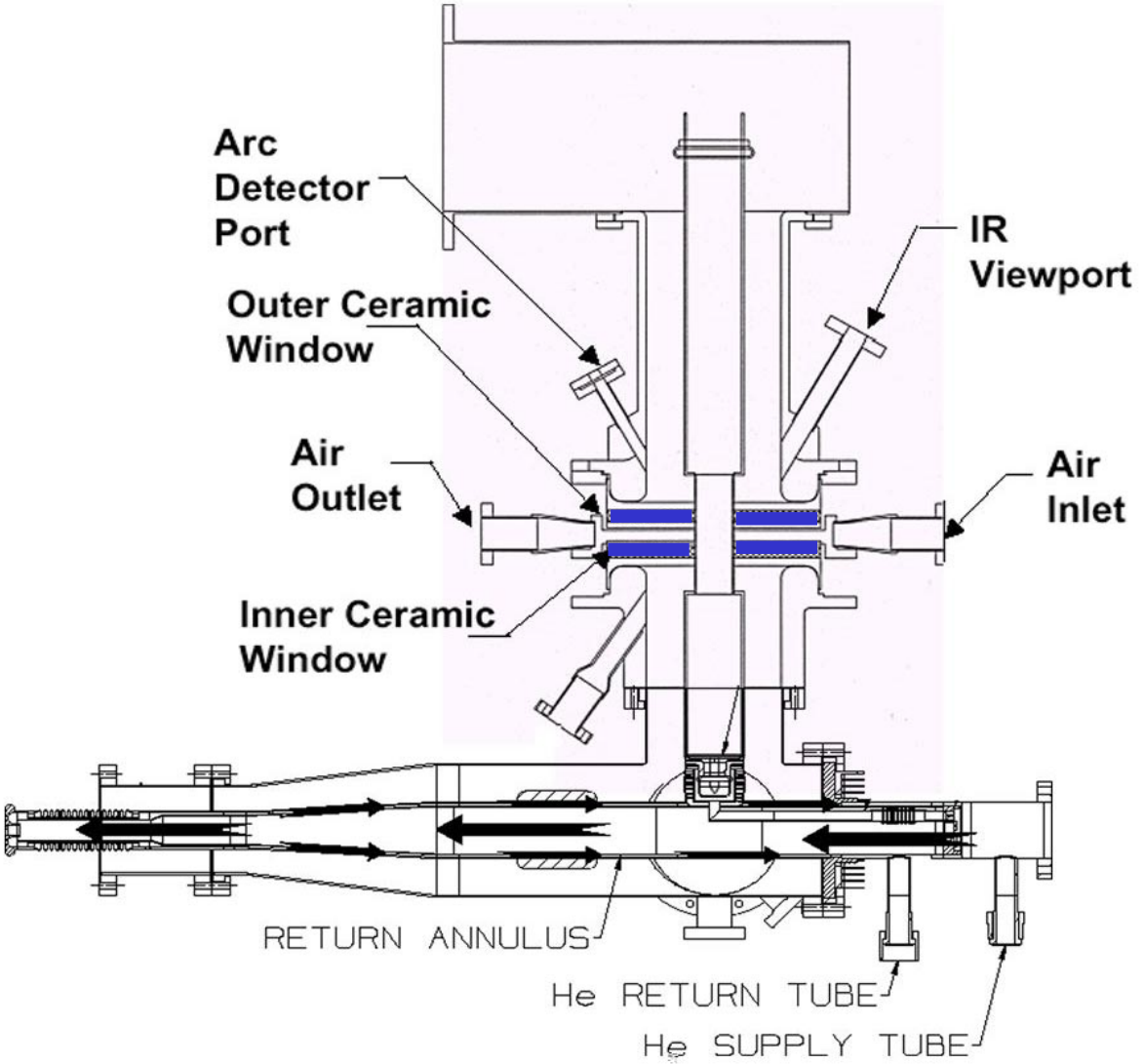
**Main difficulties:**

- **multipactor at 190, 220, 290, 420 kW**
- **tip bellow failures -> change material, He cooling**
- **window glow @>400 kW ->grit-blasting**



# Tentative conclusions

- RF windows can reach:
  - 800 - 1000 kW (APT, KEK) for coax type
  - 500 kW (Cornell) for WG type
- couplers can reach 400 kW in operating conditions
- multipactor remains an issue that can be alleviated by DC biasing (LHC, KEK), good pumping, surface conditioning, ....
- tunability is troublesome at high power (bellows, enhanced complexity, ...) (LHC, APT)
- no long term reliability data at high power (> 120 kW)
- very few window manufacturers (Marconi, Thomson, Toshiba, ...)
- ....